Argonian.

Predominant.—Hydrogen and proto-hydrogen.

Fainter.—Helium, unknown gas (λ 4451, 4457), proto-magnesium, proto-calcium, asterium.

Alnitamian.

Predominant.—Hydrogen, helium, unknown gases (λ 4089·2, 4116·0, 4649·2).

Fainter.—Asterium, proto-hydrogen, proto-magnesium, proto-calcium, oxygen, nitrogen, carbon.

Proto-metallic lines relatively thick, hydrogen relatively thin.

Crucian.

Predominant. — Hydrogen, helium, asterium, oxygen, nitrogen, carbon.

Fainter.—Proto-magnesium, proto-calcium, unknown gas (λ 4089·2), silicium.

Achernian.

Same as Crucian.

Taurian.

Predominant.—Hydrogen, helium, proto-magnesium, asterium.

Fainter. — Proto-calcium, silicium, nitrogen, carbon, oxygen, proto-iron, proto-titanium.

Algolian.

Predominant —Hydrogen, proto-magnesium, proto-calcium, helium, silicium.

Fainter. — Proto-iron, asterium, carbon, proto-titanium, proto-copper, proto-manganese, proto-nickel.

Rigelian.

Predominant.—Hydrogen, proto-calcium, proto-magnesium, helium, silicium.

Fainter.—Asterium, proto-iron, nitrogen, carbon, proto-titanium.

Markabian.

Predominant.—Hydrogen, proto-calcium, proto-magnesium, silicium.

Fainter.—Proto-iron, helium, asterium, proto-titanium, proto-copper, proto-manganese, proto-nickel, proto-chromium.

Cygnian.

Predominant.—Hydrogen, proto-calcium, proto-magnesium, proto-iron, silicium, proto-titanium, proto-copper, proto-chromium.

Fainter. — Proto-nickel, proto-vanadium, proto-manganese, proto-strontium, iron (arc).

Sirian.

Predominant.—Hydrogen, proto-calcium, proto-magnesium, proto-iron, silicium.

Fainter.—The lines of the other proto-metals and the arc lines of iron, calcium, and manganese.

Proto-metallic lines relatively thin, hydrogen relatively thick.

Polarian.

Predominant—Proto-calcium, proto-titanium, hydrogen, proto-magnesium, proto-iron, and arc lines of calcium, iron, and manganese.

Fainter.—The other proto-metals and metals occurring in the Sirian genus.

Procyonian.

Same as Polarian.

Aldebarian.

Predominant. — Proto-calcium, arc lines of iron, calcium, and manganese, proto-strontium, hydrogen.

Fainter. — Proto-iron and proto-titanium.

Arcturian.

Same as Aldebarian.

Antarian.

Predominant. — Flutings of manganese.

Fainter.—Arc lines of metallic elements.

Piscian.

Predominant.—Flutings of carbon.

Fainter. — Arc lines of metallic elements.

We may take for granted that as time goes on new intermediate genera will require to be established; the proposed classification lends itself conveniently to this, as there are no numerical relations to be disturbed.

A still more general chemical classification is the following, it being understood that in it only the most predominant chemical features are considered, and that there is no sharp line of separation between these larger groups. The peculiar position of calcium and magnesium render this caveat the more necessary.

Highest temperature.

Gaseous stars	Proto-hydrogen stars ...	Argonian.	
		Alnitamian.	
	Cleveite gas stars	Crucian.	Achernian.
		Taurian.	Algolian.
Proto-metallic stars		Rigelian.	Markabian.
		Cygnian.	——
		——	Sirian.
Metallic stars...		Polarian.	Procyonian.
		Aldebarian.	Arcturian.
Stars with fluted spectra		Antarian.	Piscian.

Lowest temperature.

The detailed chemical facts to be gathered from the definitions of the several genera indicate many important differences between the order of appearance of chemical substances in the atmospheres of the stars and that suggested by the hypothetical "periodic law." Special investigations are in progress by which it is hoped some light may be thrown on this and other points of a like nature.

THE USE OF PHOSPHORUS IN THE MANUFACTURE OF LUCIFER MATCHES.

OUR readers will be aware that about a year ago the attention of the public was specially directed to the danger which attends the use of yellow phosphorus in the manufacture of matches. Numerous cases of necrosis of the jaw were reported, and some of these occurred in factories which were supposed to be conducted on hygienic principles. There were also some cases in these factories which had been intentionally concealed from the proper authorities. The Home Office accordingly requested Profs. Thorpe and Oliver to inquire and report upon the subject, and shortly afterwards these authorities were joined by Dr. Cunningham, senior dental surgeon to the London Hospital, in view of the importance of the practical dental question at issue.

These three gentlemen have now presented their report, and it has been issued (January 1899) as a Blue Book of 236 pages. It is to be hoped that the Government will see their way to act promptly on the recommendations here set forth, and that by a proper system of inspection they will provide for the carrying out of the new regulations; many excellent rules for the management of match factories already exist, but in some cases these have become practically a dead letter, as they have not been enforced sufficiently stringently.

We have nothing but praise for the way in which the three investigators have carried out their work. Prof. Thorpe deals with the question from the chemical standpoint, and enters into such matters as the differences between the allotropic forms of phosphorus, the composition of phosphorus fumes, their solvent action on teeth, and the composition of the various pastes, &c., used in the manufacture of matches. Full and illustrated accounts of the process of manufacture are given, both in this and in other countries, and the precautions taken to minimise the danger to the workpeople. Dr. Oliver, whose work in connection with other dangerous trades is so well known, approaches the question from

the medical standpoint, and the portion of the report for which he is responsible is clear, concise, and intensely practical. Dr. Cunningham's report contains a full account of phosphorus necrosis, and is illustrated by diagrams showing various stages of the disease in the teeth and jaws. This condition is the most frequent and most obvious of the poisonous effects of phosphorus; it is not by any means the only one. He also gives in full the precautions which should be adopted in all factories for combating the injurious effects of the poisonous fumes. There are various appendices which give in detail the facts upon which the main body of the report is founded.

The whole report is a clear evidence of the painstaking way in which the Commission has carried out of its work, and is specially valuable, seeing that the investigators have visited various foreign countries in order to compare what is being done there with what occurs in our own country. An admirable summary of conclusions is furnished by Dr. Arthur Whitelegge, the chief inspector of factories. The main conclusions are as follows:—

In the match industry two forms of phosphorus are used: *yellow phosphorus*, which is highly poisonous, and gives off poisonous fumes which consist mainly of low oxides of phosphorus; and *red phosphorus*, which does not fume, and is hardly poisonous even if swallowed.

Then, as is well known, there are two principal varieties of matches used: the "safety matches," which are tipped with a composition free from phosphorus; the surface on which they strike is covered with a composition of which red phosphorus forms a part. The "strike anywhere" matches are tipped with a paste containing yellow phosphorus in a proportion which varies from 3 to 30 per cent.; but in this country not more than 6 or 7 and often less than 5 per cent. is used. It is in the making of such matches only that danger arises. Attempts are being made to make "strike anywhere" matches which contain no yellow phosphorus, and rewards have been offered for an effective match of this kind, but up to the present these efforts have not been successful; either such matches do not strike anywhere, or else they are violently explosive.

The specially dangerous processes in the manufacture of matches containing yellow phosphorus are *mixing* the paste, *dipping* the wood or wax stems, *drying* the bundles after dipping, and *boxing* the dried matches; it is the last process which involves the most handling of the matches.

The rules that already exist require (1) natural and mechanical ventilation to be efficient in the rooms where these processes are being carried out; (2) effectual means to prevent the fumes entering other parts of the factory; (3) that no person shall be employed who has suffered from necrosis, or had a tooth extracted; (4) that persons suffering from toothache shall be at once medically examined; (5) notification of cases of necrosis is obligatory; and (6) proper conveniences for washing shall be provided.

Both here and abroad many firms have done a good deal more than this: the dental supervision has been efficient, and the introduction of elaborate machinery instead of hand labour in the four dangerous processes has done more than anything else to lessen the danger. In some foreign countries the precautions taken are in advance of our own, but in this country special praise is given to the Diamond Company's factory at Liverpool, where cases of phosphorus necrosis have never occurred. In Germany, Austria, and Switzerland, there is, however, the surreptitious manufacture of matches as a home industry to be contended with; this disastrous practice has, happily, not been attempted in Great Britain.

The main point which the Commission had to decide was undoubtedly whether they should recommend the use of yellow phosphorus to be prohibited. We may give their decision in their own words:—

"So far as the home consumption is concerned, it does not seem that the prohibition of the use of yellow phosphorus would involve any serious hardship, and this course has already been adopted by Denmark, and decided upon by Switzerland, care being taken at the same time to prohibit the use or importation of yellow phosphorus matches. But neither of these countries has or had any export trade to lose. The United Kingdom, Belgium, Sweden, and Japan, manufacture largely for export,[1] and it is feared that immediate prohibition of yellow phosphorus would at once divert that portion of our trade to other countries, unless international agreement upon the subject was arrived at. If grave injury to the health of the workpeople were inevitable, the loss of the trade might well be regarded as the smaller sacrifice of the two, but the result of the inquiry points to a different conclusion. With due selection of workpeople, strict medical and dental supervision, proper structural and administrative conditions, and substitution of machinery for hand labour, it seems that the dangers hitherto attending the use of yellow phosphorus can be overcome."

We need not go into the details of all the precautions set forth; they will involve revision of the present rules, and put briefly they consist of absolute cleanliness, perfect ventilation, medical selection of workpeople (children, debilitated persons, and those with unsound teeth being excluded), compulsory dentistry, substitution of machinery for direct handling, and limitation of the percentage of phosphorus in the paste.

We learn that in Russia a tax is imposed upon the manufacture of yellow phosphorus matches, with the result that safety matches are displacing the "strike anywhere" kind. The Commissioners make no recommendation that a similar tax should be imposed here; they are also silent in regard to recommendations concerning international agreement in view of the total prohibition of the use of yellow phosphorus. No doubt this would have been the most stringent and the most effective course to adopt. But legislation is a slowly moving machine, and international legislation a more cumbrous one still. Recognising this, the report suggests what is a more practical remedy, and certainly a more immediate one. What has been accomplished by the Diamond Factory at Liverpool should be made compulsory elsewhere, and for the sake of the workers it is to be hoped that there will be no delay in carrying the suggested rules into operation.

MIMICRY AND WARNING COLOURS.[2]

IT is just twenty years ago since the late Charles Darwin called the writer's attention to a little paper, by Fritz Müller, published in *Kosmos* for May 1879, and containing a new suggestion concerning the theory of mimicry. It was the writer's misfortune to have foreseen that the principle discovered by Müller was likely to exert a profound influence on certain biological problems of which the solution had up to that time been unattempted, and he accordingly introduced the new idea to the entomologists of this country by inserting a translation of the paper in the *Proceedings* of the Entomological

[1] For foreign and colonial use, especially in hot and humid climates, the yellow phosphorus matches keep better and resist damp.

[2] "Natural Selection the Cause of Mimetic Resemblance and Common Warning Colours." By Edward B. Poulton, M.A., F.R.S. (*Journ. Linn. Soc. Zoology*, vol. xxvi. pp. 558–612.)